FORESTRY RESEARCH

WHAT'S NEW IN THE WEST AUGUST '74
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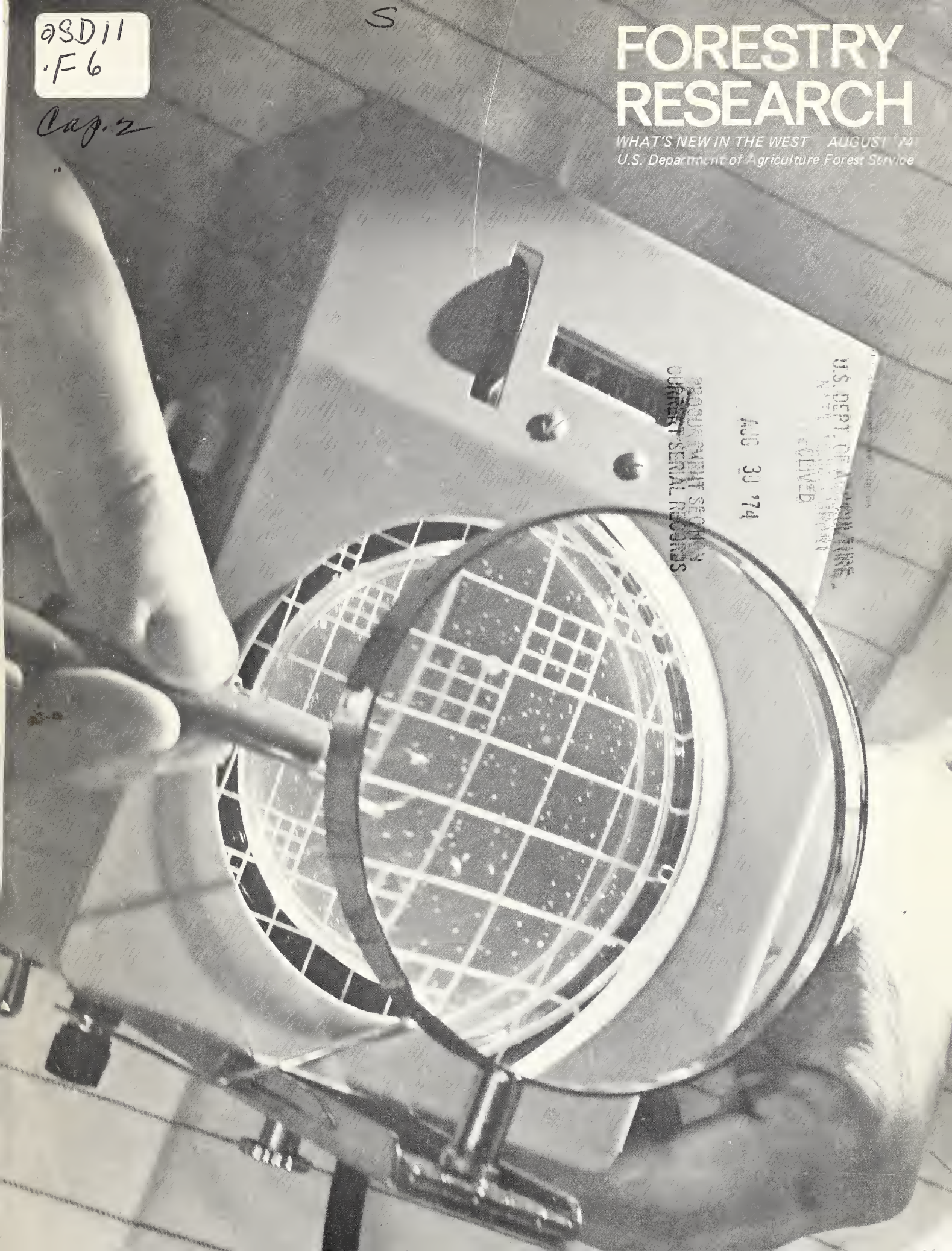

Library network

Bruce Yerke (l.) and Al Groncki (r.) helped to start the California Forest Research Information Network.

The people who put together CALFORNET —— a library service especially designed for California foresters —— wanted it to be three things at once.

They wanted it to provide a once-a-month listing of good books and technical papers that people working in the wildland sciences could ask for, and could get —— with no hassle.

They wanted it to be an information switching center, where someone could phone or write in about a forestry problem and get a good answer.

Finally, they wanted it to be a place where the forester who hears about a book or paper not already included in CALFORNET's monthly listing could apply for the item.

Now in its second year, CALFORNET —— the California Forest Research Information Network —— has been all of these things. And, while it does have its flaws, the system has generally been working very well.

CALFORNET was created by a small group of people who felt that too many useful research findings were spending too much time on library bookshelves. The group —— made up of people from the Forest Service's Regional Office in San Francisco and from the Pacific Southwest Forest and Range Experiment Station in Berkeley —— credits members Al Groncki and Bruce Yerke with much of the work that went into starting up CALFORNET.

aids California foresters

Yerke, who is in charge of the Station's Science Literature Services, started the library of the California Maritime Academy and was a librarian at Southern Methodist University, the Asia Foundation, and the California College of Arts and Crafts before joining the Forest Service 14 years ago. Forester Al Groncki has been with the Forest Service for 21 years. A former District Ranger, Groncki is currently general forestry assistance officer for the California Region's Division of State and Private Forestry.

Perhaps most challenging to the CALFORNET staff at the Pacific Southwest Station are reference questions. Here are some examples:

- A recreation and lands officer, interested in campground reservation systems, wanted to know what had been written about them. These systems, which enable the would-be camper to reserve his spot in the woods before he even steps out his front door, were new at the time the request came into Berkeley. The staff did a thorough literature search but was unable to discover any helpful books or papers. They did, however, put the recreation and lands officer in touch with a systems designer who had worked on the computerized reservation system used by the California Department of Parks and Recreation.
- A National Forest biologist told CALFORNET she needed literature and photographs of the Shasta salamander, a rare species endemic to northern California. The library sent her three monographs, and told her that the author of one was very interested in talking with her about her salamander studies. The library also arranged for photographs to be taken of Shasta salamanders preserved in the nearby Museum of Vertebrate Zoology at the University of California.
- A National Forest hydrologist wanted to know more about the environmental effects of road oils. The CALFORNET group found one entry in *Pollution Abstracts,* but was unable to find anything else on the subject in other standard references such as *Biological Abstracts*, and *Government Reports Announcements*. So, they asked at the library of the Institute of Transportation and Traffic Engineering on the UC Berkeley campus. From its collection, the Institute library was able to loan reports to the hydrologist.
- A member of a National Forest planning team wanted to look at impact statements for winter sports developments. CALFORNET contacted the Environmental Protection Agency office where impact statements are filed. This office ran a computer check, and came up with seven titles on the topic.

"When people ask us for a bibliography on clearcutting, or on some other topic that has been written up a lot, we can usually get the bibliography together fairly quickly," says Vincent Aitro, reference librarian at the PSW Station. "We have standard indexes such as *Forestry Abstracts* and the *Bibliography of Agriculture* right here in the PSW library. We're only a few blocks away from the UC campus, and we have access to the subject bibliographies there."

"But, we usually need more time to answer a request for information on new or specialized topics. If we find that very little or nothing has been written on a subject, we usually try to put the person asking the question in touch with people who are currently doing research on the topic."

CALFORNET is based upon interlibrary cooperation. Collections open to CALFORNET use include those of the UC School of Forestry and Conservation and of the University's Forest Products Laboratory. The 125 or so items on each Monthly Alert are not only the acquisitions of the PSW Station library, but are also new materials available from these two campus libraries.

Also important to the success of CALFORNET are some 35 county and small town libraries in northern California. As members of either the Mountain Valley, North Bay, or North State Cooperative Library System, (cont'd on page 12)

A virus that kills

The year 1973 might well be called "The Year of the Tussock Moth." By the end of the summer, the fuzzy little caterpillars (larvae) had chewed through some 690,000 acres of forest in eastern Oregon and Washington and another 122,000 acres in Idaho and Montana. It is the worst outbreak ever recorded in the Northwest.

But for Dr. Hank Thompson, concern about the tussock moth began back in 1964, 4 years after he joined the Forestry Sciences Laboratory in Corvallis, Oregon, as a research entomologist with the Forest Service. That was about the time people were becoming concerned about the effects of pesticides and other chemicals on the environment. DDT was going out of favor, and foresters were anxious to find some new control methods —— techniques that would be safer for use around fish and other wildlife. Natural biological controls looked promising because most insects have diseases and are subject to attack by parasites and predators. Thompson's assignment was to set up a new research project to explore the use of natural biological controls to halt the spread of forest insect outbreaks.

One of Thompson's first concerns was to narrow the problem. "Everyone tries to do too much," he says. "That just dilutes the effort and you can't solve any one problem." Since the mid-1960's, almost all of his work has been on the tussock moth and the viruses and other disease agents which attack it. Most of the research has been on study of a nucleopolyhedrosis virus which helps control the tussock moth outbreaks in nature.

One of the difficulties with entomological research is the cyclic nature of insect outbreaks. "They'll be up for a few years, then down," Thompson says. "When they're down, you can't even find a tussock moth in the woods."

In 1964, outbreaks appeared in several parts of the West, giving scientists an opportunity to work on the tussock moth. In the succeeding years, Thompson's research team of four scientists and four technicians has made considerable progress in developing a sound biological control for the tussock moth. They have:

- Developed techniques to raise tussock moths in the laboratory for experimental purposes. Thousands of moths have been reared on artificial diets and used in the research.
- Identified the natural microbial enemies (viruses and bacteria) which attack the tussock moth at various stages of development.
- Established procedures required for mass production and purification of a naturally occurring virus of the tussock moth and demonstrated its safety to nontarget organisms.
- Conducted experiments to test aerial sprays of the virus and a bacterium for control of tussock moths.
- Studied the natural effects of the virus on tussock moth populations in the woods.

As in any pioneering research effort, there have been a few failures —— like the year in northern California when an aerial application of virus didn't work at all. But they've also made a lot of progress. This past summer, aerial spray tests with the virus and bacterium were conducted on small plots in the Wallowa-Whitman National Forest near Enterprise, Oregon. Both treatments were highly effective. Population reduction with one formulation of the virus averaged 99.9 percent. A bacterial treatment achieved 98 percent reduction.

Thompson is most enthusiastic about the virus because it works against the tussock moth in nature. The bacterium (*Bacillus thuringiensis*, or BT) will kill tussock moths and is commercially available, but it is not a part of their natural ecosystem. Both micro-organisms, however, have demonstrated considerable promise as safe, sound tools for pest management. (cont'd on page 12)

tussock moths

One step in the process of purifying the virus is to check the bacteria count of virus cultures (cover). PNW entomologist Ken Hughes (above) uses this electron microscope in his work. Procedures for purifying the virus were developed by Dr. Mauro Martignoni (right), a PNW microbiologist.

Using trees, land-forms, to reduce sound levels

How long has it been since you were free of the distraction of man-made mechanical sounds? Noise is increasing. The annual rise in sound level of an average community in the U.S. has been one decibel annually for the past 20 years. Because a 10 decibel increase approximates a doubling of sound level, the noise volume that now exists in American communities is four times what it was two decades ago. Medical science is now relating many health and hearing problems to excessive noise. The most obvious is hearing damage. More insidious is the way excessive noise can aggravate certain nervous disorders.

At the University of Nebraska at Lincoln, David I. Cook, Professor of Mechanical Engineering, has been testing environmental means of reducing mechanical sound levels. Cooperating with Professor Cook is David F. Van Haverbeke, research forester with the Rocky Mountain Forest and Range Experiment Station at Lincoln.

Cook and Van Haverbeke set as their original research goal an evaluation of trees and shrubs as noise screening agents along highways. "Trees and other forms of vegetation are known to have some effect on the transmission of sound," they said at the outset of their first study, "but precise information on the use of greenery as noise screens is meager. We want to derive accurate, useful information about the extent to which trees and shrubs absorb noise."

Here's how they went about their experiment. First, they chose three types of noise — highway truck noise, passenger car noise, and bus stop noise — for the study. Second, they tape-recorded and analyzed these sounds, establishing an average noise spectrum for each. Third, they selected, as test areas, seven of the shelterbelts planted in Nebraska during the Prairie States Forestry Project of the late thirties and early forties.

Fourth, using a high-output sound system and a magnetic tape data recorder with sound level meter, they played back the sounds through the tree and shrub barriers of the shelterbelts. They measured the sound level at various distances from the belts and, for purposes of comparison, replayed their tapes of traffic noise in areas that did not have shelterbelts.

They found that wide belts of tall, dense trees can reduce sound levels by 5 to 8 decibels, and that a reduction of 10 decibels was "not unusual." When soft surfaces such as grass or plowed ground existed adjacent to the trees, noise levels went down 8 to 12 decibels.

They also collected data on how variations in planting density, shelterbelt width, and tree height affect the amount of noise reduction. Detailed results of the research are in "Trees and Shrubs for Noise Abatement," University of Nebraska Research Bulletin 246, July 1971, by Cook and Van Haverbeke. (Copies, at 50 cents each, are available from University Information Services, Lincoln, Nebraska 68501).

After finishing this initial study, Cook and Van Haverbeke went on to evaluate how effective land-forms such as highway cuts, fills, and small hills, are as noise shields.

David F. Van Haverbeke (l.) and David I. Cook (r.) recorded highway noise levels for their study of natural sound barriers.

As test sites, they selected four areas along highways outside of Lincoln. There, they conducted noise screen trials, comparing the value of tree-covered land-forms with that of land-forms that did not have any trees or shrubs. The forms tested were of different heights, and the two researchers accounted for this variable in their work.

In "Trees, Shrubs, and Land-Forms for Noise Control," an article from the November-December 1972 issue of the *Journal of Soil and. Water Conservation* (27(6):259-261), Cook and Van Haverbeke say their initial results indicate that land-form barriers should be "high enough to screen the noise source from view at the location to be protected." Trees, shrubs, and grass planted on and around the land-form will extend the range of protection and will further reduce the noise level, they say.

Along main roads, 6- to 8-foot-high land-forms or other solid barriers, with dense shrubs in front and taller trees behind, will serve as effective noise screens. Cook and Van Haverbeke plan to publish additional findings this summer.

The two Nebraska researchers are discovering principles that planners and developers can use to appreciably reduce traffic noise. Their present findings are particularly applicable to highway and to urban conditions. They'd like to do more research on urban residential situations.

In recent years, noise control has received increasing emphasis in the construction of transportation vehicles. This new attention to reducing vehicular noise, when coupled with the application of tree and land-form noise control principles, may lead to a more quiet and peaceful environment. □

This Morbark Chiparvestor was used in the lodgepole pine stands of Wyoming's Teton National Forest as part of an experiment conducted by the Forest Service and Champion International.

Finding uses for logging leftovers

When it comes to separating the big problems in forestry from the little ones, a lot of people put "getting rid of forest residues" on their "big problems" list.

It is a persistent problem —— one that can last for at least as long as it takes the slash strewn on the forest floor to decompose.

And, it is a pervasive one —— a trouble not only to the person trying to manage a ponderosa pine forest in the Southwest, for example, but also to his counterpart working in the Douglas-fir timberlands of the Pacific Northwest.

Three Forest Service Experiment Stations in the West have asked their researchers to tackle this problem. In addition, the agency's Forest Products Laboratory in Madison, Wisconsin, has 12 men working on complementary studies. And, the engineers at the Forest Service's San Dimas Equipment Development Center in southern California are doing their share by trying to perfect the kinds of harvesting equipment most likely to be needed in residues utilization.

Although they are working in different forest types, the goal of all these people is the same —— to find ways to recover virtually every bit of wood on a timber sale.

In moderate amounts, logging residues such as tops, branches, and cull (unmerchantable) logs, may be beneficial —— they may add nutrients to the soil, reduce erosion, protect seedlings, and provide cover for wildlife. In excessive quantities, however, logging residues are a fire hazard and an eyesore. By taking up the space that might otherwise be occupied by seedlings, the residues inhibit reforestation of the logged area. Perhaps worst of all, residues may represent a waste of a valuable resource —— wood fiber.

The problem is especially severe in the cold, dry climate of the northern Rocky Mountains, where wood does not decay as rapidly as it does in warmer, more humid regions. Many stands of old timber in the Rockies have a high proportion of dead and damaged trees that, when added to logging slash, create large volumes of residues. In parts of Montana and northern Idaho, for example, logging residues may exceed 100 tons per acre. In the Forest Service's five-state Northern Region, logging, thinning, and road building create an estimated 25 million tons of wood residues annually.

In Missoula, Montana, Ron Barger, research forester with the Forest Service's Forestry Sciences Laboratory there, is in charge of a utilization and marketing research unit. One current study is on how to utilize the residues in the overmature lodgepole pine stands of Wyoming's Teton National Forest. Barger and his men, who work for the Intermountain Forest and Range Experiment Station, are collaborating on the Teton study with two other Forest Service groups —— the National Forests of the Intermountain Region and the Forest Products Laboratory —— and with Champion International Corporation.

The group recently completed one part of the Teton work —— comparing what they term "conventional harvesting" with a newer approach to logging, "near-complete harvesting." (cont'd on p. 10)

Logging residues

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Barger explains that in conventional harvesting all merchantable trees are utilized to a minimum top diameter of 6 inches. All residues were either dozer-piled and burned or broadcast burned.

Near-complete harvesting, in contrast, involved not only the production of logs, but also the chipping of materials that would have been burned in a conventional harvesting operation.

The near-complete harvesting was done with equipment that Barger says is relatively new to western logging. They used:

- a Drott feller-buncher, capable of shearing off and bunching trees up to 24 inches d.b.h.;
- a Timberjack grapple-skidder that can skid whole trees as well as logs; and
- a Morbark high-capacity mobile chipper that can chip whole trees up to 20 inches d.b.h.

Trees were sheared and bunched, then skidded whole to the landing with the grapple-skidder. Logs were bucked out and piled for hauling to Champion International's mill at Dubois, Wyoming.

Tops, branches, cull sections, and other residues were chipped and piled.

Results of the Teton test showed that near-complete harvesting produced 35 percent more fiber, by weight, than conventional harvesting, Barger says. Chip recovery averaged about 50 dry tons per acre.

The Forest Products Laboratory helped with the work involved in evaluating whether the chips can be used in making paper, particleboard, mulch, or other products.

Two reports on the study are available from the Intermountain Station; more are planned. One paper is "Utilization of Lodgepole Pine Residues in Wyoming Increases Fiber Yield" (Research Note INT-160-FR2), a report in which Intermountain Station scientists R. B. Gardner and David W. Hann compare yields from conventional harvesting with those from near-complete harvesting. The other is "Volume of Wood, Bark, and Needles After Clearcutting a Lodgepole Pine Stand." Authors Al Foulger and John Harris of the Forest Products Laboratory describe the wood-bark ratio of residues remaining after conventional harvesting. Their report appeared in the February 1973 *Journal of Forestry* (71(2):93-95); the Forest Products Laboratory (Box 5130, Madison, Wisconsin 53705) has reprints.

In the Pacific Northwest, the biggest residues problem is in the old-growth Douglas-fir and ponderosa pine forests of the Cascades. In these two forest types, it's not unusual to find anywhere from 100 to 200 tons of logging slash per acre —— a staggering amount by anyone's standards.

The Pacific Northwest Forest and Range Experiment Station has 10 people working in Portland and in Seattle on this problem. They are members of the Station's Forest Residues Reduction Program, and they are putting a priority on what the program's manager, Hugh McLean, says will be interim guidelines for forest residues management in the Pacific Northwest.

The Station group is collaborating with people from the National Forests of Washington and Oregon on these guidelines. "What we want to end up with are specific recommendations that people can use in deciding how to handle the residues problem on a given piece of land," McLean says. "Back-up for each recommendation will be PNW research or other documentation."

Target date for the interim guidelines publication to come off the press is November 1974. In the meantime, currently available papers written by the residues reduction team include John M. Pierovich and Richard C. Smith's "Choosing Forest Residues Management Alternatives" (General Technical Report PNW-7-FR2); James O. Howard's "Logging Residue in Washington, Oregon, and California —— Volume and Characteristics" (Resource Bulletin PNW-44-FR2) and John D. Dell and Franklin R. Ward's "Logging Residues on Douglas-fir Region Clearcuts —— Weights and Volumes" (Research Paper PNW-115-FR2).

In Southwestern forests, residues may comprise up to one-fifth of the total cubic foot volume harvested by conventional methods. "A big enough amount," say researchers George Sampson and Hal Worth of the Rocky Mountain Forest and Range Experiment Station, "to warrant an attempt at utilization." Sampson, a research forester, and Worth, leader of the Station's forest products research unit, helped put together the residues utilization experiment that was conducted last summer on the San Juan National Forest in Colorado and the Apache National Forest in Arizona.

Logging residues

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It was a group venture: participants included the Station, the Four Corners Regional Commission, Southwest Forest Industries, and the Forest Service's Southwestern and Rocky Mountain Regions and Forest Products Laboratory.

The equipment used in the study included a Nicholson Utilizer. This machine both debarks and chips pulpwood, sawlog tops, and waste logs at the logging site.

In the summer study, more than 300 tons of pulp chips were produced from wood that otherwise would have been left as debris in the forest. Chips were blown directly into the waiting vans and delivered to Southwest Forest Industries' pulp and paper mill in Snowflake, Arizona.

Chip samples from all types of cull materials that were run through the debarker-chipper are now being analyzed by Southwest Forest Industries for possible use in paper production, and by the Forest Products Laboratory for possible use in the manufacture of structural particleboard.

This year at the San Dimas Equipment Development Center in California, residues reduction work is one-third of the Center's total research program, according to the director there, Charles W. Howard.

This much work is necessary, Howard explains, because most of the logging equipment now on the market isn't geared to utilization of what have traditionally been regarded as waste materials.

During the past 3½ years, the Center engineers have been scouting around for machinery that could —— with some modification —— be used in recovering residues. "If we put in one parking lot all the machinery we have considered for residues work, we'd need a lot the size of a football field," Howard says.

They've evaluated machines used for stump removal, and for splitting large stumps. They've looked at equipment that can be used for sizing and cleaning bark and charred or rotten material. They've examined ring, rosser-head, and drum debarkers. And, they're studying two processes for removing bark from small, forked limbs —— both procedures involve using 2-inch, hardened steel balls and a chain flail.

All that is just for openers. The San Dimas men are working with people from Developmental Sciences, Inc., on high-pressure water jets that both groups hope can be used for cutting up and cleaning large, dirty slash.

Center engineers are working on two other approaches to the slash problem. One is slash treatment which, in the past, has involved breaking up the residues. The intent of slash treatment programs is to reduce fire hazards and to speed up the return of nutrients to the soil. So, San Dimas researchers have tested an assortment of crushers, choppers, cutters, and chippers, as well as flails and hammer mills.

A smashing idea, except for the fact that the machines tested so far have proven less than ideal. "Not surprising," Howard explains, "they were the best we could find, but they weren't originally intended for slash treatment. So, we've started a slash lab, and we're trying to come up with the ultimate mechanical cutter."

A second method is controlled burning of the residues. Both San Dimas and the Pacific Northwest Station are doing a lot of work on this approach.

San Dimas and the Experiment Stations are working with people at the Forest Products Laboratory in Madison, Wisconsin, the largest research unit in the Forest Service. Scientists there have the work —— and the fun —— of seeing what products can be made from the residues that have been partially processed at logging sites.

The Laboratory is studying residues from both western softwoods and northern hardwoods. (Another Forest Service unit, the Southern Forest Experiment Station, is in charge of utilization of southern hardwoods.)

Laboratory researchers are putting a lot of time on the possibilities of using residues to make structural particleboard. Stronger than conventional particleboard, this proposed building material would help supplement the plywood supply.

The men working in the Laboratory's pulp and paper research program are trying to see how much use can be made of rough chips —— those with bark still attached.

Dr. H. O. Fleischer, the Laboratory director, claims there's "no question" that residues can be utilized. "By being thrifty with what we formerly regarded as unwanted materials," Fleischer states, "we can increase the yield of wood fiber, and can help to make harvested areas easier to manage." □

CALFORNET

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they help fill the Alert requests sent to them by State or industrial foresters in their areas. If these libraries don't have an Alert item, they turn to another CALFORNET cooperator —— the State of California library in Sacramento.

The staff of the Forest Service's Berkeley library has a lengthy list of other libraries to which they sometimes go for help. Their list includes branch libraries at the University of California campus, corporation libraries, and the National Agricultural Library in Beltsville, Maryland.

The big program had small beginnings. It started out with the PSW Station giving Klamath National Forest people approximately the same services which the Experiment Station provided its own scientists. "Operation Klamath Desk" went over well, and more National Forests were added to the experiment. Today, CALFORNET includes all of the National Forests in the Forest Service's California Region.

A lot of people have written to the PSW Station, asking if they are eligible to receive CALFORNET services. To employees of the California Region of the Forest Service, or of the Pacific Southwest Station, the answer is "yes." Their access to CALFORNET is the PSW library. Also eligible are graduate students and members of the faculty of UC's School of Forestry and Conservation. Their link with CALFORNET is the forestry library on the campus. Finally, the network may be used by employees of the California Division of Forestry, and by Californians who are consulting, industrial, or extension foresters, faculty members at schools of forestry, or instructors of college-level courses about land-use management. They can get in on CALFORNET through their local city or county library.

During CALFORNET's first year there have been a lot of compliments for the new system. But, there also have been some complaints. Some foresters working in industry say that the service is too slow. Some National Forest people think the three-day limit imposed on much CALFORNET material is too restrictive. Perhaps the biggest problem is the demand that is sometimes created for a certain book or paper that appears on the Monthly Alert. When the library has only a few copies of a popular item, a lot of people have to do a lot of waiting. But, on the whole, this first year has been a very good one for CALFORNET. □

Tussock moth virus

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The virus is particularly potent, Thompson says. The tussock moth larvae eat the virus while feeding on tree foliage. As the virus multiplies and spreads through the larva, it causes a degenerative disease which kills the insect. A larva which has been killed by virus dissolves into a messy residue that's highly infectious to other insects.

In nature, the virus contributes to the collapse of tussock moth outbreaks —— usually on a 3-year cycle. "We believe the virus plays an important role in the termination of most outbreaks," Thompson says. "We don't always find virus in the early stages of an outbreak. If we do, it's at a very low level. The virus is probably there, but at such low levels that it is hard to locate."

Last year, the third year of the cycle in the original Blue Mountain outbreak, the virus was much more prevalent. It came in too late to prevent severe defoliation, but the principle still holds.

"Everything we know about the tussock moth points to a pattern of outbreak and decline —— usually on a 3- to 4-year basis. And the virus usually plays an important role."

The virus is not the only natural control factor, but is "one we can readily manipulate," Thompson says. Other factors which contribute to the collapse of tussock moth outbreaks are climatic conditions, parasites and predators, and food supply for the insects.

Even though results of last summer's field tests were excellent, Thompson says larger field tests are essential. Techniques also need to be developed for mixing large quantities of the virus into aerial sprays before the group can recommend use of the virus or the bacterium on mass infestations.

One of the first questions that comes up about viruses is safety. Could they be harmful to wildlife or to man when sprayed in the forest? Extensive safety tests are required by the Environmental Protection Agency before a material can be

Tussock moth virus

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registered for use. Most of this work has already been done. Dr. Mauro Martignoni, a microbiologist on Thompson's staff, has directed preliminary tests on rabbits, rats, mice, deer, quail, fish, and bees —— and none were harmed by the virus. The work with rabbits and fish has been done in the Corvallis laboratory. Other work has been contracted or conducted by the U.S. Department of the Interior's Fish and Wildlife Service.

Martignoni says that studies with fish are especially important. "If there is a hazard to any form of life other than the tussock moth, we'll probably find it with fish," he says. The tussock moth, like all insects, is eurythermic —— its temperature fluctuates with that of the environment. Fish are the same way —— their cells grow at temperatures of about 68° to 76° F. The tussock moth virus will multiply at this temperature range, but will become inactivated when exposed to the constant higher temperatures of homoiothermal or warm-blooded animals. So far, all tests gave negative results, indicating that the nucleopolyhedrosis virus is not pathogenic to fish.

According to Thompson, viruses are "among the more specific pathogens. A good many have only one host." The virus Thompson's team is working with is a nucleopolyhedrosis virus, of which there are several hundred varieties. Most of these viruses cause diseases of the larvae of the tussock moth and other Lepidoptera such as the cabbage looper, cotton bollworm, forest tent caterpillar, and hemlock looper. The specific virus under study is infectious to only a few closely related species of tussock moths.

Working from electron microscope pictures, researchers have identified at least three distinct viruses that kill the tussock moth. One, a bundle virus, was selected for intensive studies, primarily because it seems to cause greater breakdown of the larvae, says Kenneth Hughes, a research entomologist on Thompson's staff.

Hughes, who has studied hundreds of electron microscope pictures of the virus, talks about its structure: the virus comes in bundles with anywhere from 1 to 20 individual virus rods per bundle. The bundles, surrounded by lipo-protein membranes, are grouped into a polyhedron. Because it acts as a protective device, the polyhedron enables the virus to survive in the environment. Without the polyhedron, the virus breaks down quickly and is destroyed in sunlight. Enclosed in the polyhedron, the virus can last for years, perhaps indefinitely, if conditions are ideal.

Ask Hughes if the virus is alive, and he gets a quizzical look. "The polyhedron is a protein crystal," he says. "It grows as a crystal grows. If virus particles are there, they are incorporated in it. They reproduce, but so do other complicated chemicals not generally thought of as living."

"Perhaps we're at the shady margin where it isn't even appropriate to make a distinction," he says.

The structure of the virus also affects the way it acts inside the tussock moth. In feeding, the tussock moth eats not only the virus, but also the polyhedra which enclose them. When the polyhedra reach the midgut of the insect, they come in contact with an alkaline solution, which dissolves the protein base of the polyhedron and allows the virus to spread through the insect's bloodstream.

Researchers don't really know what happens after that. Hughes would like to know, and perhaps one day the pictures will yield a clue. But right now, the important thing is that the virus does the job. Somehow, the virus is transmitted to various parts of the insect, where it multiplies, breaks down cell tissue, and eventually kills the insect.

What's ahead now for Thompson's research staff? "A year or two more of field testing this particular virus against the tussock moth," he reports. Thompson's group needs to conduct larger field tests of about 10,000 acres each to improve systems for producing large quantities of virus, and to improve spray formulations. Some of this work will be done by other research units of the Forest Service, or will be contracted. In Corvallis, a PNW Station team is working, under the direction of Dr. George Markin, on the problems of spray application and equipment.

Thompson looks forward to tackling a new problem, perhaps working with a disease of another forest insect. "I may be optimistic," he says, "but I believe this is one of the most promising areas for research. When we learn how to work with, and manipulate, the ecological system in our forests, then I think we'll have less insect damage and more effective long-term insect control." □

Publications

Streamflow increases after chaparral conversion

Residents of central and southern Arizona are concerned about the availability of water supplies needed for both municipal and agricultural purposes. Since 1953, scientists at the Rocky Mountain Station laboratory in Tempe, Arizona, have investigated methods of increasing water yields. Research Hydrologist Paul A. Ingebo reports on one such study in the Proceedings of the 1972 Meetings of the Arizona Section, American Water Resources Association, and the Hydrology Section, Arizona Academy of Science His discussion is entitled "Converting Chaparral to Grass to Increase Streamflow"; copies are available from the Rocky Mountain Station.

Two comparable watersheds, both located southwest of Prescott, Arizona, and both supporting medium-density chaparral stands, were selected for experimentation in 1958. On the two areas, which were temporarily labelled watersheds "A" and "B", precipitation as well as streamflow timing and volume were carefully measured through 1966. Streamflow from the test watersheds was synchronized prior to treatment of watershed B in 1967. On the average, live water flowed from watershed B only 8 days longer per year than from watershed A.

Treatment on 38 acres, or 15 percent of watershed B, consisted of eliminating deep-rooted chaparral plants that were using water from the moist environment along stream channels within the area.

Since treatment, streamflow has been continuous in watershed B. In the control area, watershed A, streamflow is intermittent. Watershed B today produces an annual average of 167 more days of streamflow than watershed A. This is a yearly increase of 0.61 inches of water from the entire watershed, or 3.9 inches of water from the treated portion of the watershed.

'Local seed source' theory tested in California study

Geneticist M. Thompson Conkle may have found some exceptions to the long-standing rule that planting with local seed source is the best way to go. Subjects of Conkle's interest are pines growing at low-, mid-, and high-elevation plantations located along a west-east transect of the Sierra Nevada at about 39° north latitude. These plantations are the proving grounds for the progeny of both local and non-local parents.

In "Growth Data for 29 Years from the California Elevational Transect Study of Ponderosa Pine" (FR2), Conkle says that the progeny from mid-elevation parents rank tallest in all three plantations. But this rating may only be temporary, at least in the high-elevation site. There, according to Conkle, dominance of the mid-elevation progeny is being challenged by the progeny of the higher elevation seed parents.

On the basis of progeny performance during the first 29 years of the experiment, Conkle has decided that the optimum seed collection zone lies between 2,000 and 4,000 feet elevation on the west slope of the Sierra Nevada.

For restocking sites that are above 5,000 feet elevation, Conkle opts for the high-elevation sources, for two reasons. First, the present growth advantage of the mid-elevation progeny in high-elevation sites isn't all that significant. Second, the experimental pines are only at mid-rotation age. They may, in later years, show some major growth differences.

If, however, the growth relationships Conkle describes do stay the same through the rotation age of the pines, this would be an indication that mid-elevation seed collection areas really are the best seed source for any plantings to be done along the west slope of the Sierra Nevada.

Conkle's paper, the third in a series about the California transect, was originally published in the March 1973 issue of *Forest Science* (19(1):31-39).

Water quality not damaged by fertilizer, study shows

When severe forest fires burned large portions of the Wenatchee and Okanogan National Forests in Washington in July 1970, scientists from the Forest Hydrology Laboratory in Wenatchee, Washington, were called in to help National Forest administrators determine the effect of the fire and subsequent rehabilitation efforts on stream quality. Specifically, they were asked to find out if fertilization with urea would introduce excessive amounts of nitrate and ammonia into streams which are the source of municipal water supplies. Their hunch was that it wouldn't, but the fire and subsequent reforestation efforts offered a good opportunity to gain more precise information on this question.

Urea is an organic nitrogen fertilizer that hydrolyzes to ammonium carbonate and may be converted eventually to nitrate-N in the soil. Adding large quantities of urea creates a potential source of both ammonia-N and nitrate-N in streamflow. The application of urea following fire is of particular concern because soil-plant nutrient cycles are severed. Without vegetation present to utilize the added nitrogen, the potential for movement of nitrogen ions from the soil into streamflow is increased.

After 2 years of study, National Forest administrators got their answer —— no damage to water quality. Even though urea was applied at the rate of 69 pounds per acre, water quality was not reduced. Fertilization did increase nitrate-N levels in the stream, but the amount was some 30 times less than the permissible level for the watershed under municipal use.

For details, see Research Note PNW-203-FR2, "Stream Chemistry Following a Forest Fire and Urea Fertilization in North-Central Washington," by Arthur R. Tiedemann.

Balloon logging tested in the Idaho Batholith

Off they went, into the wild blue yonder —— logs, that is —— carried high above the treetops under a huge, onion-shaped balloon. This sight startled many visitors to the Boise National Forest in Idaho, where engineers and foresters from the Intermountain Forest and Range Experiment Station and from the Boise Cascade Corporation evaluated the use of balloon logging from 1971 through 1973.

The site of the balloon logging experiment, Garden Valley Ranger District, lies on the Idaho Batholith. This geological formation is a mass of solid rock covered by a thin layer of soil. It covers 19,000 square miles in central Idaho —— about 20 percent of the State's land area. Much of the Batholith is steep and rugged; when disturbed by man or nature, the soil mantle tends to slide downhill over the bedrock, like snow slips off a tin roof.

The forests of the Idaho Batholith hold large volumes of valuable ponderosa pine and Douglas-fir. At times in the past, tractor logging and road-building in the Batholith triggered erosion.

A team of Intermountain Station researchers, after investigating other harvesting methods, decided that a balloon logging system, successful in Oregon, might work on the Boise Forest, as well as in other areas in the West that have fragile soils.

R. B. Gardner and W. S. Hartsog of the Intermountain Station's Forestry Sciences Laboratory in Bozeman, Montana, and G. L. Jacobsen, who was at that time a forester on the Boise National Forest, describe the first season's operations in "Balloon Logging," an article published in the February 1973 issue of *Agricultural Engineering* (54(2):14-17).

The balloon logging system used was expensive. Equipment, for example, cost more than $400,000. Production ranged from 30 to 250 logs

in a 10-hour day, depending on operating conditions. The yarding cost ranged from $33 to $67 per thousand board feet. The authors point out, however, that although initial production costs were high, the costs decreased as the season progressed.

The system is excellent for selective logging, because the logs are lifted vertically above the understory, and there is minimal soil disturbance.

Gardner, Hartsog, and Jacobsen say that in order for a balloon logging operation to be economical, volumes per acre in the area to be logged should probably be greater than 12,000 board feet. The terrain should be relatively flat and unbroken, and drainage bottoms should be wide enough to accommodate landing sites.

Reprints (R-276-FR2) of "Balloon Logging" may be ordered from the Intermountain Forest and Range Experiment Station in Ogden.

Estimating logging residues is subject of INT report

Estimates of logging residues —— the portions of trees left unused after harvesting operations —— are vital to the land manager for planning timber production (see story, this issue).

A report on this subject has been published by the Intermountain Forest and Range Experiment Station. Theodore S. Setzer, in "Logging Residues on Harvesting Operations, Western South Dakota, Wyoming, Utah, and Colorado," (Research Paper INT-123-FR2), reports results of his studies to estimate volumes of logging residues. In his paper, Setzer includes factors that yield estimates of the total volume removed from inventory.

Subtracting the product volume from initial inventory of a timber stand does not necessarily indicate the residual stand, Setzer says. To calculate inventory remaining after logging, one must subtract logging residues as well as product volume from the prelogging inventory, according to Setzer.

He's concluded that residues from saw log operations, though a relatively small percentage of net product volume, represent a significant underutilized portion of the total that is removed from growing stock.

Multispectral scanner, computer, used for survey

Phil Weber and Bob Aldrich of California and Frank Sadowski and Fred Thomson of Michigan know some of the Georgia countryside as well as any native. The four, specialists in remote sensing, have done a lot of work in that State, testing out the M-7 multispectral scanner that was developed by Sadowski and Thomson's employer, the Environmental Research Institute of Michigan.

Still somewhat of a newcomer to the art of remote sensing, multispectral scanning holds the promise of a fast, accurate way to get much-needed inventories of land use. It's based on the fact that each object in a natural landscape absorbs, transmits, reflects, and emits radiation.

Weber says the different spectral properties of trees, plants —— even roads and ponds —— in a landscape give each of these elements a distinctive, multispectral signature. Notations of these signatures, collected by an airborne scanner, can be tape-recorded, then translated by a hybrid analog/digital computer system into categories, each telling whether the land is being used for row crops, for growing a stand of upland hardwoods, or for some other purpose.

The problem is that what you see is not always what you get —— from the scanner, that is. No combination of a multispectral scanner, or MSS, with the analog/digital computer system that the four men have tested, has yet reached the 95 percent accuracy level that is expected of any competent human photo interpreter.

The Georgia experiment, then, is just one among many tests designed to make a successful combination out of multispectral scanning and computerized mapping. The study is described in "Land Use Classification in the Southeastern Forest Region by Multispectral Scanning and Computerized Mapping." A reprint from the Proceedings of the Eighth International Symposium on Remote Sensing of Environment, this paper is available from the Pacific Southwest Station in Berkeley, the Forest Service unit with which Weber and Aldrich work.

From overflights of their two test sites, the experimenters wanted to prepare land use maps showing approximately how many acres are im-

proved pasture, how many are bottomland hardwood, and how many are in the assortment of other terrain classes. They also wanted to see if the signatures taken from one flight line could be extended —— used in classifying other flight lines.

One of the two computer systems they tested did well in recognizing young orchards, but misclassified other groves, mistakenly identifying very young orchards as bare soil and incorrectly labelling mature orchards as upland hardwoods. However, the overall attempt at signature extension was "reasonably successful," they said.

Yield tables for some sites questioned in PNW paper

If a land manager relies on data from standard yield tables in determining productivity and stocking capacity for some forest sites, he could be easily misled into investing in unneeded or unwise silvicultural treatments.

This is what Colin MacLean and Charles Bolsinger of the Pacific Northwest Station in Portland, Oregon, suggest in "Estimating Productivity on Sites with a Low Stocking Capacity" (Research Paper PNW-152-FR2).

There is a discrepancy between the timber volumes of normal yield tables and the actual productivity of some types of forest land in the West, MacLean and Bolsinger say. They believe there is a real danger of overestimating potential timber yield from some currently low-stocked stands.

Yield tables, meant to be an aid in predicting the amount of timber a given site can produce, are not available for every type of land. In fact, the tables are usually prepared for average or for better than average forests. The problem comes when data from these normal tables are used to predict productivity on stands that have a good site index but are capable of supporting only a few trees.

MacLean and Bolsinger found that about half of the commercial forest land (255 out of 535 plots) in eastern Oregon and northern California is unable to support the stocking levels indicated by normal yield tables. These plots tended to be arid and marginally stocked sites at the lower forest fringe. Such stands often appear to be understocked when, in fact, the sites may be producing to their capacity.

Ideally, yield tables should be stratified by plant communities, the authors say. But, they admit that to put such tables together would require "a massive effort." As an interim measure, MacLean and Bolsinger outline procedures for adjusting available yield tables to fit local needs. Their methods apply to eastern Oregon and northern California. Their best method requires an ecological study of the plant communities in the area to be inventoried. Their second-best method is based on a regression approach for discounting values of existing yield tables. The two men say that the use of either of these techniques will produce more accurate evaluations than will the use of the yield tables now available.

Western gall rust spreads in late spring

Western gall rust, *Peridermium harknessii,* is one of several diseases that infect ponderosa pines planted in the Great Plains. Its natural rate of spread is slow. This rate, however, is increased when infected nursery seedlings are outplanted in diverse locations.

Glenn W. Peterson, research plant pathologist at the Forest Service's Rocky Mountain Station laboratory in Lincoln, Nebraska, has been studying ways to stop this disease from spreading in nursery stock transplants.

In "Dispersal of Aeciospores of *Peridermium harknessii* in Central Nebraska," a January 1973 *Phytopathology* article (63(1):170-172), Peterson describes the critical spore dispersal period. Using spore traps in a ponderosa pine stand infested with gall rust, he found aeciospores in the air during May and June. Eighty percent of the dispersal was accounted for in May.

Peterson concluded, "Because all aeciospores were essentially dispersed during May and June, fungicide applications could be limited to these months. Also, because spore frequency is very low the last 2 weeks of June, and because first-year seedlings are very small at this time, there is little risk in leaving the seedlings unsprayed for the 2-week period."

Determining dollar values of timber, water, forage

In the article "Valuation of Timber, Forage, and Water from National Forest Lands," economist Paul F. O'Connell proposes a method for assigning dollar values to three competing resource uses —— lumber, livestock grazing, and the production of water needed to irrigate feed grains. Application of O'Connell's economic model yields resource values ranging from the maximum amount a producer can afford to pay for primary resource inputs over a short period of time to the actual price paid.

O'Connell, who heads a watershed evaluation project at the Tucson, Arizona, laboratory of the Rocky Mountain Station, applied his model to the timber, forage, and water resources of the National Forest lands in the Salt-Verde Basin of Arizona. He found that the maximum "arguable" value for each of these resource products was significantly higher than the price paid. Thus, current prices fail to reflect the full value of these resources to society.

Coupling this information with expected future demand-supply conditions, the forest manager is equipped with an economics tool that can help him select the land treatment program best suited to the public's needs.

"There is considerable apprehension about using economic criteria for making decisions," O'Connell explains. He says that this is understandable because "some forest products —— natural beauty, wildlife, and outdoor recreation opportunities —— are not sold in the marketplace."

"It is very difficult to fit these non-market outputs into an economic model," O'Connell states, "because people do not judge the relative worth of these outputs on an economic basis. This is precisely why there should be multi-objective alternatives identified for all major land management decisions."

These objectives are: economic efficiency, regional development, and environmental quality. For timber, forage, and consumptive water, however, the use of economic criteria is, in O'Connell's opinion, "the most logical way to judge the relative worth of these forest products to society."

The article was published in the December 1972 *Annals of Regional Science*. The Rocky Mountain Station has reprints.

Bulletin on pocket gophers, Colorado ranges, available

Got a gopher problem? Are you looking for information to help you evaluate the impact of gophers on mountain ranges? If so, you might want to have the Rocky Mountain Station send you a copy of "Pocket Gophers and Colorado Mountain Rangeland." A complete résumé on the pocket gopher, this publication, Bulletin 554S of the Colorado State University Experiment Station, was written by R. M. Hansen, Colorado State University; G. T. Turner and A. L. Ward, Rocky Mountain Forest and Range Experiment Station; and V. H. Reid and H. P. Tietjen, Bureau of Sport Fisheries and Wildlife.

Topics treated include: distribution and adaptations of pocket gophers; population biology of the northern pocket gopher; food habits and competition; effects of pocket gophers on range; 2,4-D, vegetation, and pocket gophers; and control of pocket gophers.

The bulletin summarizes findings from studies made throughout the West, with emphasis on those from Colorado.

Effects of road work, logging, monitored

The North and South Fork watersheds of Caspar Creek, a small coastal stream in northern California's redwood region, are the subject of an ambitious watershed study that won't be finished until 1977.

Purpose of the watershed work is to find out what effects logging and road construction have on streamflow, sedimentation, aquatic habitat, and fish populations.

The watersheds of both the North and South Forks support second-growth forests of redwood, Douglas-fir, grand fir, hemlock, and bishop pine. The North Fork is still the control area; the South Fork, in line with the project's master plan, was logged recently —— roads were put in and about 65 percent of the volume was removed.

Researchers J. S. Krammes of the Forest Service and David M. Burns of the California Division of Forestry wrote "Road Construction on Caspar Creek Watersheds . . . 10-year report on impact" (Research Paper PSW-93-FR2) at a mid-point in the project; the roads were in, but the logging was still to come.

The building of the roads and the collapse of an old splash-dam —— a remnant of the logging done in the South Fork in the late 1800's —— had a lot to do with the great increase in suspended sediment that occurred during the first year after construction, Krammes and Burns say. Levels measured during the following winters were above preconstruction level, but were not excessive.

When the trees came down —— so the roads could be built —— water temperatures went up, but only slightly, and not enough, the authors suggest, to injure the native populations of steelhead trout and salmon that inhabit the creek.

In this preliminary study, the researchers say dissolved oxygen concentrations were "not adversely affected by construction activities or by removal of stream-side vegetative cover." The amount of living space for the anadromous fish was not significantly affected by road construction.

The young-of-the-year fish populations decreased immediately after the roads were built, but Krammes and Burns estimate that the decline was "within the range of natural fluctuation reported for other California streams."

There was a change in the composition of the streambed particle size, but it was not detrimental to the fish habitat.

Notes about Forestry Research: What's New in the West

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